RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

July 13, 2007

Mr. Edward Kreul
Environmental Manager
International Paper, Riegelwood Mill
865 John L. Riegel Road
Riegelwood, N.C. 28456

Re: Minor Permit Modification
International Paper, Riegelwood, N.C. Permit 24-02

Dear Ed,

This minor modification to the permit for the landfill for International Paper at Riegelwood, N.C. (Columbus County, Permit 24-02) is to expand the capacity and to improve operating techniques of the landfill. Cell 1 of the current landfill was permitted on December 30, 2002. Cell 1, a double-lined cell covering approximately 13.8 acres, was a lateral expansion of the existing unlined landfill. When Cell 1 was permitted, the planned expansion was to the north, ultimately incorporating 27.5 total acres with a disposal capacity of 2,439,000 cubic yards. The South Expansion will increase the disposal volume by approximately 147,000 cubic yards (approximately a 6% increase).

When Cell 1 was constructed, the southern limit of the liner system was approximately halfway up the soil berm of the unlined landfill. The proposed modification to Cell 1 will extend the liner system up the berm slope approximately 100-feet wide and 1,000-feet long that lies between Cell 1 and the unlined landfill, as shown on Figure A, below an in full detail on the drawings included with this submittal.

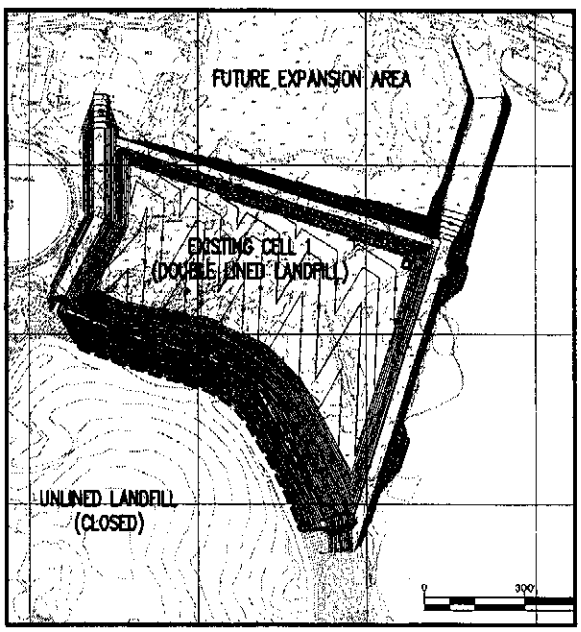


Figure A. Cell 1 South Expansion

In addition to extending the lined cell area, three other modifications are requested. Two of them relate to storm water control, and the other modifies the liner system on the slope. The four specific changes are requested in this modification are:

1. **Liner Extension**. The lined area of Cell 1 will be extended to the south by approximately 2.23 acres, as shown on Figure A. The expansion is made by covering the southern slope (which is the northern slope of the perimeter berm of the unlined landfill). The liner system will be extended up the 3H:1V slope to approximately elevation 85 (MSL), up from the existing elevation that varies from EL 55 to EL 66. The liner extension will bring the liner up to the top of the berm of the unlined landfill, as was the original intent of the design. The plans, details, and cross-section views of the expansion are presented on the attached drawings.

2. **Eliminate the double liner in the South Expansion**. Cell 1 was constructed with a leak detection layer underneath the primary liner system. However, in this proposed cell expansion area, the base grades are constructed of slightly clayey sand fill soil brought in from off-site. The entire liner system of the Cell 1 South Expansion is on a 3H:1V slope, so there is little chance for any head to build up over the liner, meaning little chance of a leak. Additionally, the underdrain system at the toe of the slope (underneath the leak detection layer) would collect any leak that might occur and return it to the wastewater treatment system. Therefore, no secondary liner system is proposed for under the expansion area, and only the primary liner system will be installed.

TABLE 1: CELL 1 LINER SYSTEM DESCRIPTION	
Primary Liner	Drainage Geocomposite 40-mil HDPE geomembrane
Secondary Liner (to be omitted in the South Expansion)	Geosynthetic Clay Liner Drainage Geocomposite 40-mil HDPE geomembrane
Underdrain (to be omitted in the South Expansion)	8-inch diameter HDPE pipe in NCDOT No. 57 stone

3. **Southwest storm water conveyances.** The bench at the southern side of Cell 1 carries storm water runoff from the soil berm to the wastewater treatment system. With the extension of the liner, the bench on the southern slope will remain in place. The bench will be used to control storm water prior to waste filling, and used to convey leachate after the cell is filled. Prior to placing waste in the South Expansion, storm water will leave the cell area by a 30-inch HDPE pipe, booted through the liner. After waste is in place, leachate will be collected by an 8-inch perforated pipe surrounded by stone. The pipe will be welded to a solid 8-inch HDPE pipe that will be booted through the liner, then gravity fed into the wastewater treatment system. Flow calculations are presented in **Attachment 1**. While booting a storm water pipe through a landfill liner system could be potentially problematic on many sites, at the International Paper landfill all water from the cell—storm water, leachate or groundwater from the underdrain system—gets pumped back to the wastewater treatment system. The southwest corner is approximately 200 feet from the wastewater treatment system, but more than 1,000 feet from the leachate collection sump. The pipe penetrations will be approximately 30 feet above the toe of the slope, and is therefore more like a penetration through the cap than through the base liner.

4. **Northwest storm water conveyance.** A storm water culvert will be placed at the northwestern corner of Cell 1, and booted through the existing liner system. As the cell is filled, storm water run-off (currently pumped from the cell by the leachate pumps) will be diverted to the culvert and will flow by gravity to the wastewater treatment system. The culvert will empty into a new drainage channel which will flow around Clarifier No. 1 and empty into the wastewater treatment system. Flow calculations are presented in **Attachment 1**. The invert of the culvert will be at approximately Elevation 36, about 15 feet above the cell floor in that area.

The South Expansion will be constructed under the same specifications and construction quality assurance plan as previously permitted. Fill placement in the South Expansion will be to approximately elevation 115 MSL, which is approximately 9 feet lower than the height considered in the stability calculations included in Appendix II of the 2002 Permit to Construct Application. Because the final elevation is lower than previously considered, no additional stability calculations are presented.

In summary, the changes presented in the minor modification for the Cell 1 South Expansion are innocuous and practical for the landfill. The expansion will cover a small area between a lined and unlined landfill, an area that should reasonably be incorporated into the landfill. Eliminating the leak detection layer on the 3H:1V slope also seems reasonable, since little head could develop over the liner on the steep slope. As the fill height increases, the storm water pipes will allow runoff to quickly be shed from the landfill, rather than relying on the leachate pumps to remove storm water after it was mixed with leachate. Removing storm water as quickly as possible helps operations and should improve the overall stability of the landfill by preventing the waste from becoming saturated.

We believe that this application is more than sufficient to allow a quick approval by the Solid Waste Section of the North Carolina Department of Environment and Natural Resources. Should you have any questions or concerns, please feel free to contact us.

Sincerely,
Richardson Smith Gardner & Associates, Inc.

Greg Mills, P.E.
Sr. Project Engineer

Gregory N. Richardson, Ph.D., P.E.

ATTACHMENT 1

STORM WATER CALCULATIONS

Richardson Smith Gardner & Associates

ENGINEERING AND GEOLOGICAL SERVICES

SHEET: /
JOB #: IP-6
DATE: 7/13/2007
BY: G. Mills
CHKD BY:

International Paper, Rigelwood NC
Culvert Analysis

Peak Flow Rate:

Drainage Area (Ac.) :	9.25	**(User Input)**	**(from Cell 1. Area is reduced to 7.7 AC after Cell 2 is capped)**
Hydraulic Length (ft) :	1475	**(User Input)**	**Head of Area 1 to End of Area 1**
Fall Along Length (ft) :	35	**(User Input)**	**EL. 70 - EL. 35**
Time of Conc. (min.) =	9.1		
Intensity (in/hr) :	7.7	**(User Input) (25 Year Storm)**	
Runoff Coefficient :	0.35	**(User Input) (EOUSD - Exhibit 1 - Cleared Conditions - Mostly sludge on the surface)**	
Q (cfs)	24.9		

Culvert Parameters: (User Input)

Allowable HW Depth (ft)	3		
Number of Pipes, N =	1	Qpipe (cfs) =	24.9
Culvert Diameter, D (in)	30		
Type of Culvert =	C-HDPE		
Culvert Length, L (ft) =	70		
Culvert Slope, S (ft/ft) =	0.005		
Manning's Number, n =	0.005		
Entrance Loss Coef., ke	0.5		
Critical Depth (ft) =	1.1		

Case 1: Inlet Control

HW/D = 1 **(User Input - From Inlet Control Nomograph)**
HW (ft) = 2.5 **INLET CONTROL GOVERNS!**

Case 2: Outlet Control

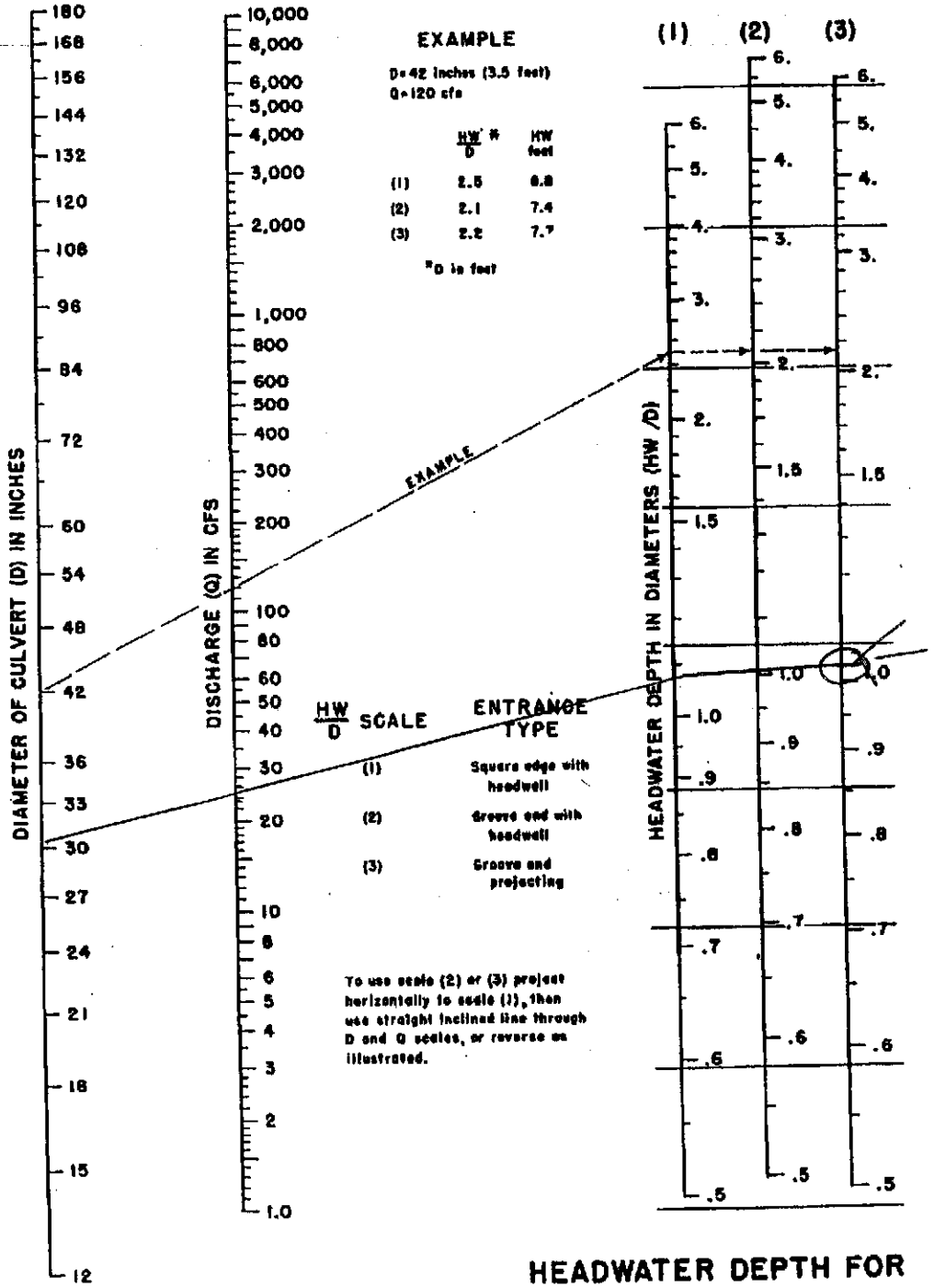
ho (ft) = 0.9
H (ft) = 1.5 **(User Input - From Outlet Control Nomograph)**
HW (ft) = 2.1

CONCLUSION: A SINGLE 30 INCH PIPE IS ADEQUATE FOR CULVERT C-1 (AT THE DIVIDING BERM B/TW CELL 1 AND CELL 2)

IP Ridgelwood
Landfill Culvert
Culvert C-1

Exhibit 11
Culvert capacity under inlet control
Circular RCP

Q = 25 CFS MAX



N10

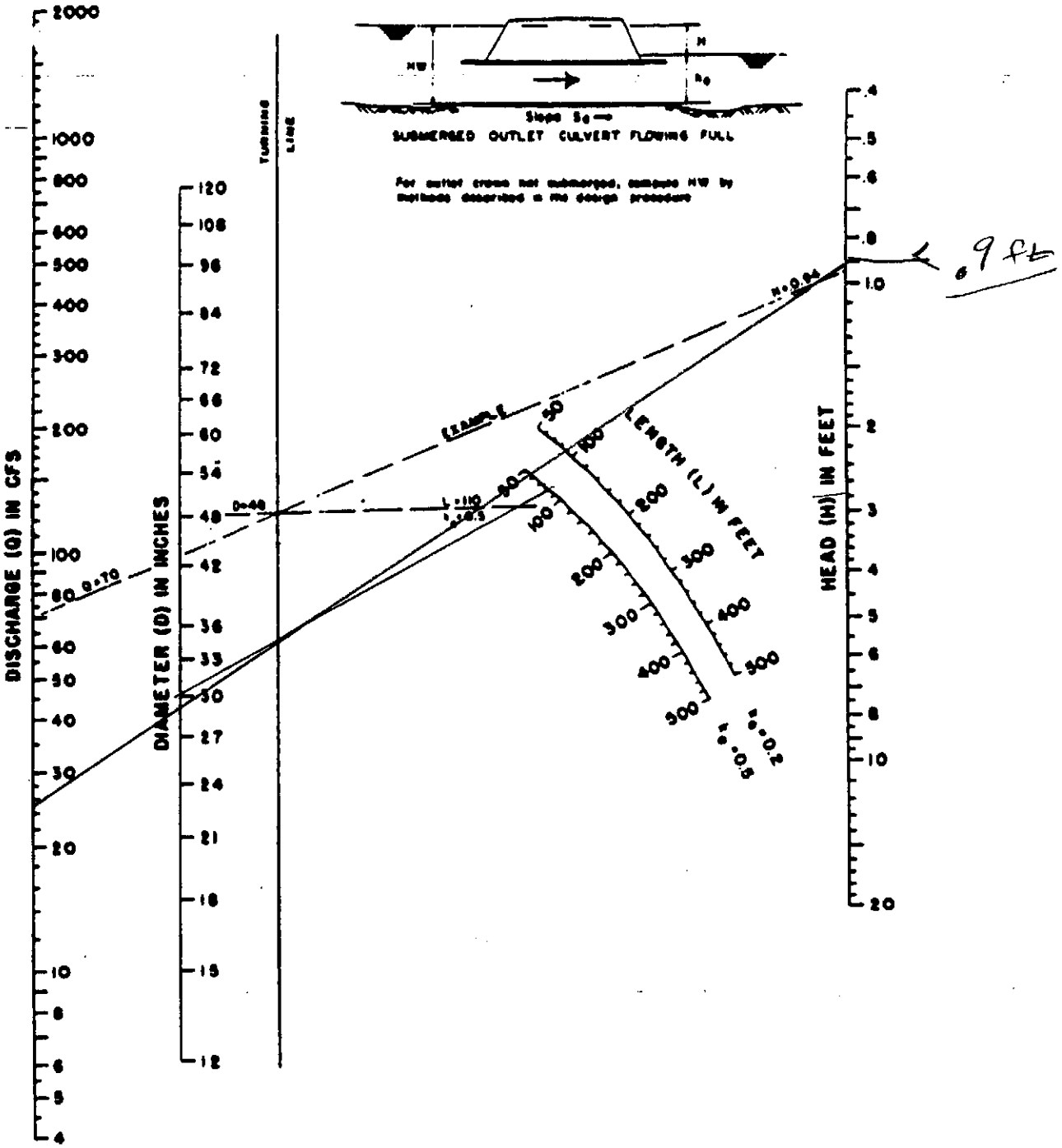
HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

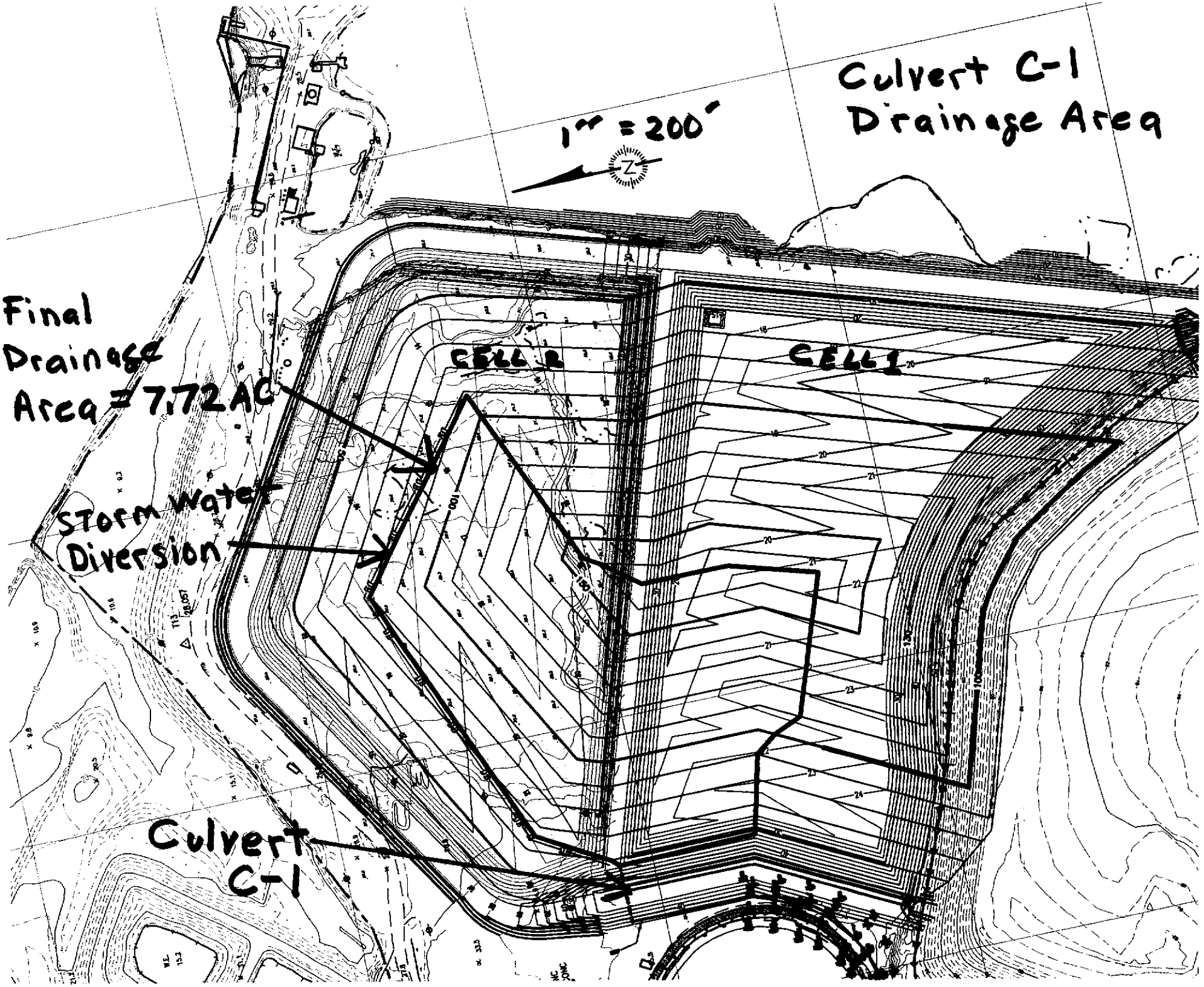
IP Riegelwood
Culvert C-1

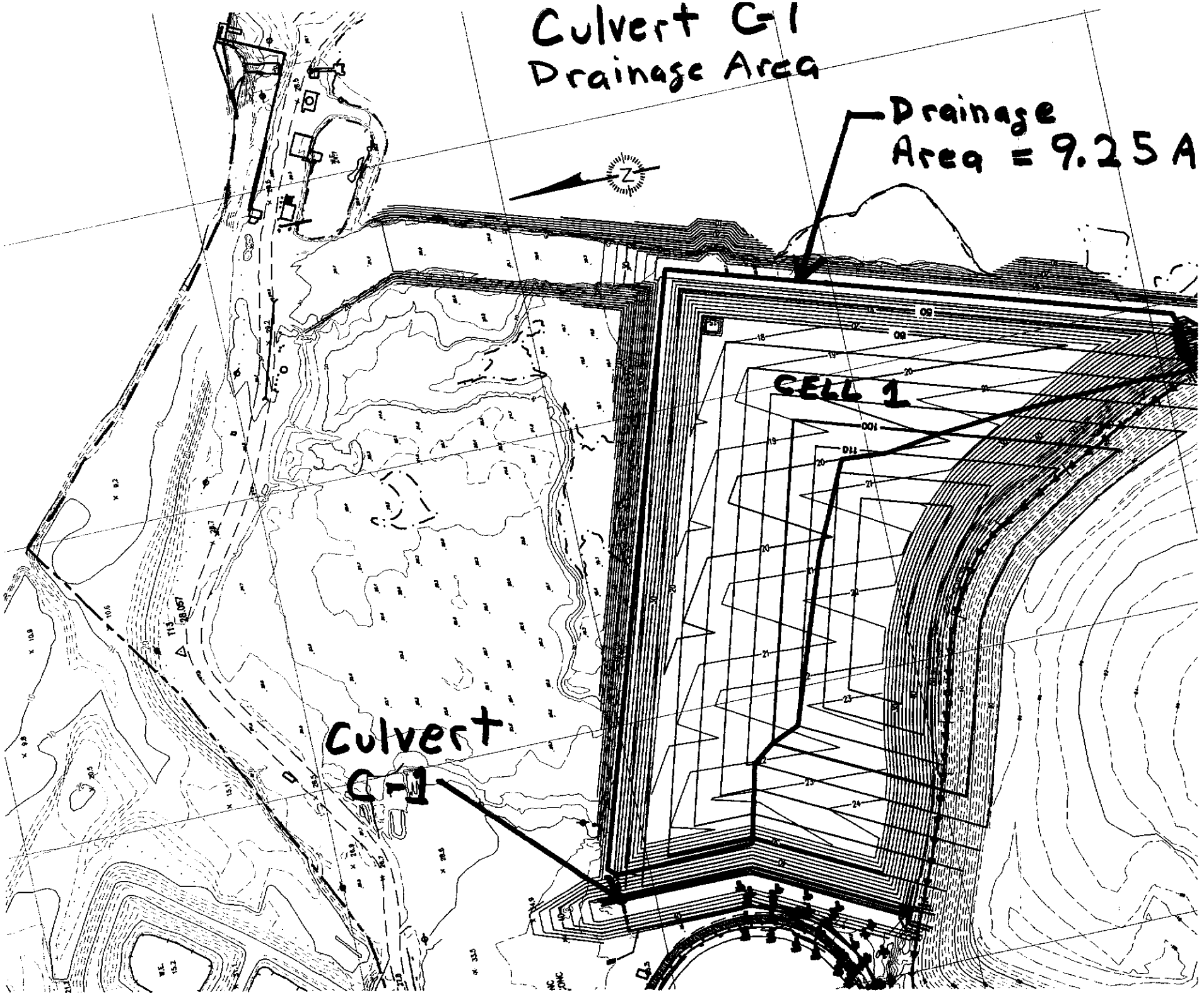
$Q_{max} = 25$ CFS



HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n = 0.012

BUREAU OF PUBLIC ROADS JAN 1963


Culvert C-1
Drainage Area
1" = 200'
Final
Drainage
Area = 7.72 AC
Storm Water
Diversion
CELL 2
CELL 1
Culvert
C-1


Culvert C-1
Drainage Area
Drainage
Area = 9.25 AC
CELL 1
Culvert
C-1

Richardson Smith Gardner & Associates

ENGINEERING AND GEOLOGICAL SERVICES

SHEET: /
JOB #: IP-6
DATE: 7/13/2007
BY: G. Mills
CHKD BY:

International Paper, Rigelwood NC
Culvert Analysis

Peak Flow Rate:

Drainage Area (Ac.) =	6.47	**(User Input)**	**(from Cell 1. Area is reduced to 7.7 AC after Cell 2 is capped)**
Hydraulic Length (ft) =	950	**(User Input)**	**Head of Area 1 to End of Area 1**
Fall Along Length (ft) =	40	**(User Input)**	**EL. 88 - EL. 48**
Time of Conc. (min.) =	5.2		
Intensity (in/hr) =	8.15	**(User Input) (25 Year Storm)**	
Runoff Coefficient =	0.4	**(User Input) (EOUSD - Exhibit 1 - Cleared Conditions - 3H:1V slopes)**	
Q (cfs)	21.1		

Culvert Parameters: (User Input)

Allowable HW Depth (ft)	4		
Number of Pipes, N =	1	Qpipe (cfs) =	21.1
Culvert Diameter, D (in)	30		
Type of Culvert =	C-HDPE		
Culvert Length, L (ft) =	70		
Culvert Slope, S (ft/ft) =	0.005		
Manning's Number, n =	0.005		
Entrance Loss Coef., ke	0.5		
Critical Depth (ft) =	1.1		

Case 1: Inlet Control

HW/D = 1 **(User Input - From Inlet Control Nomograph)**
HW (ft) = 2.5 **INLET CONTROL GOVERNS!**

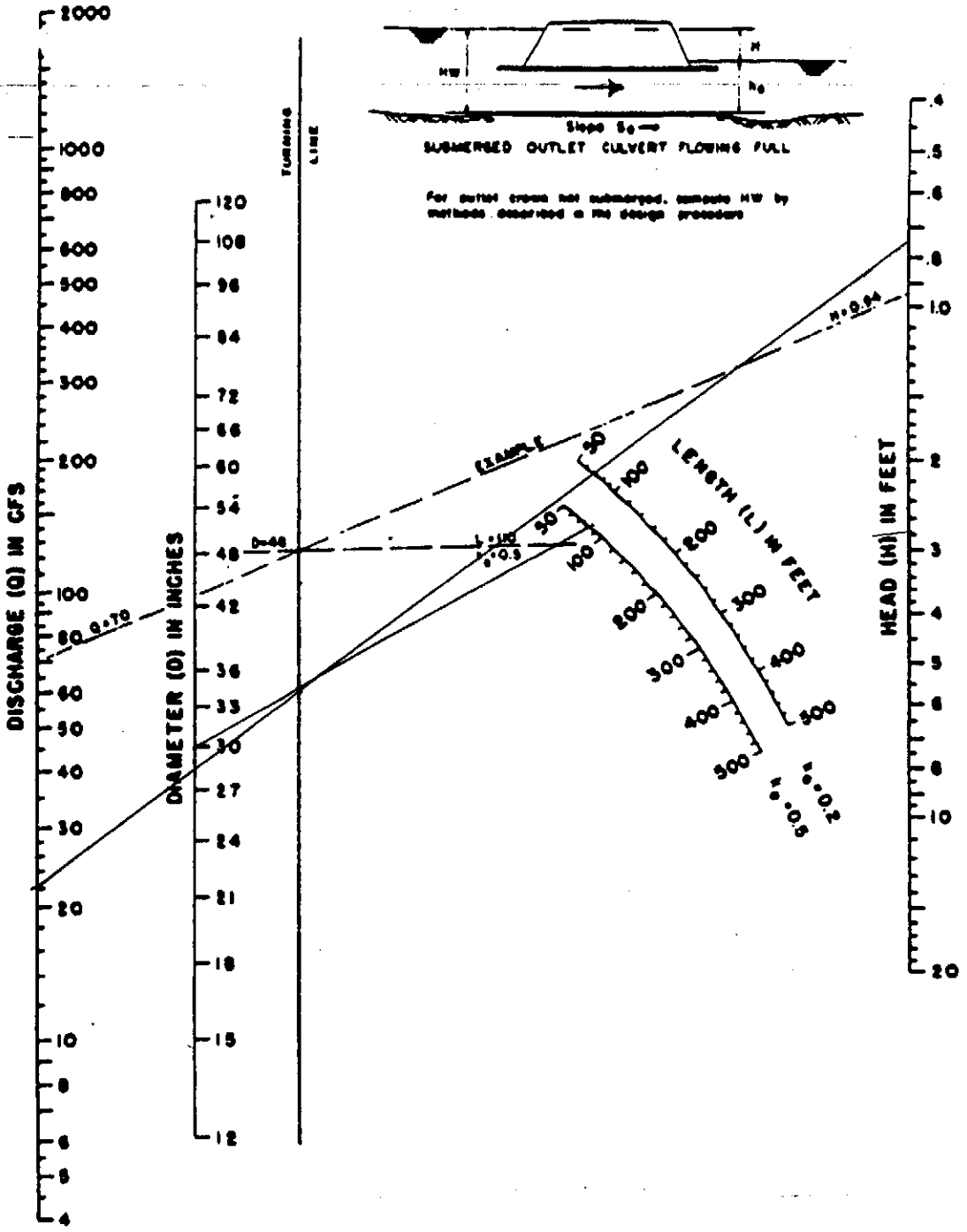
Case 2: Outlet Control

ho (ft) = 0.8
H (ft) = 1.5 **(User Input - From Outlet Control Nomograph)**
HW (ft) = 1.9

CONCLUSION: A SINGLE 30 INCH PIPE IS ADEQUATE FOR CULVERT C-2 (at the end of the bench)

Exhibit 15

IP Riegelwood
Culvert C-2

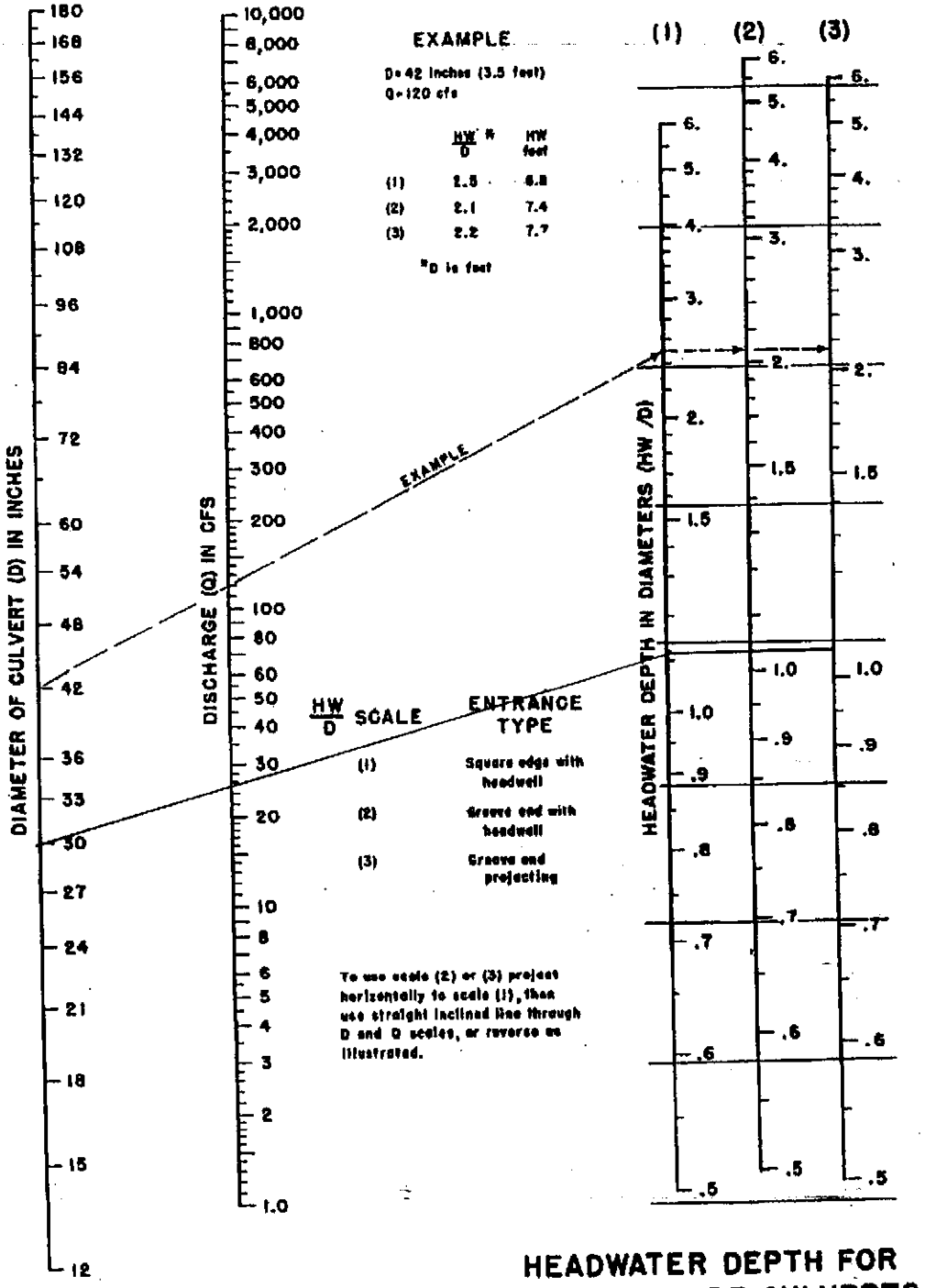


HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

Exhibit 11
Culvert capacity under inlet control
Circular RCP

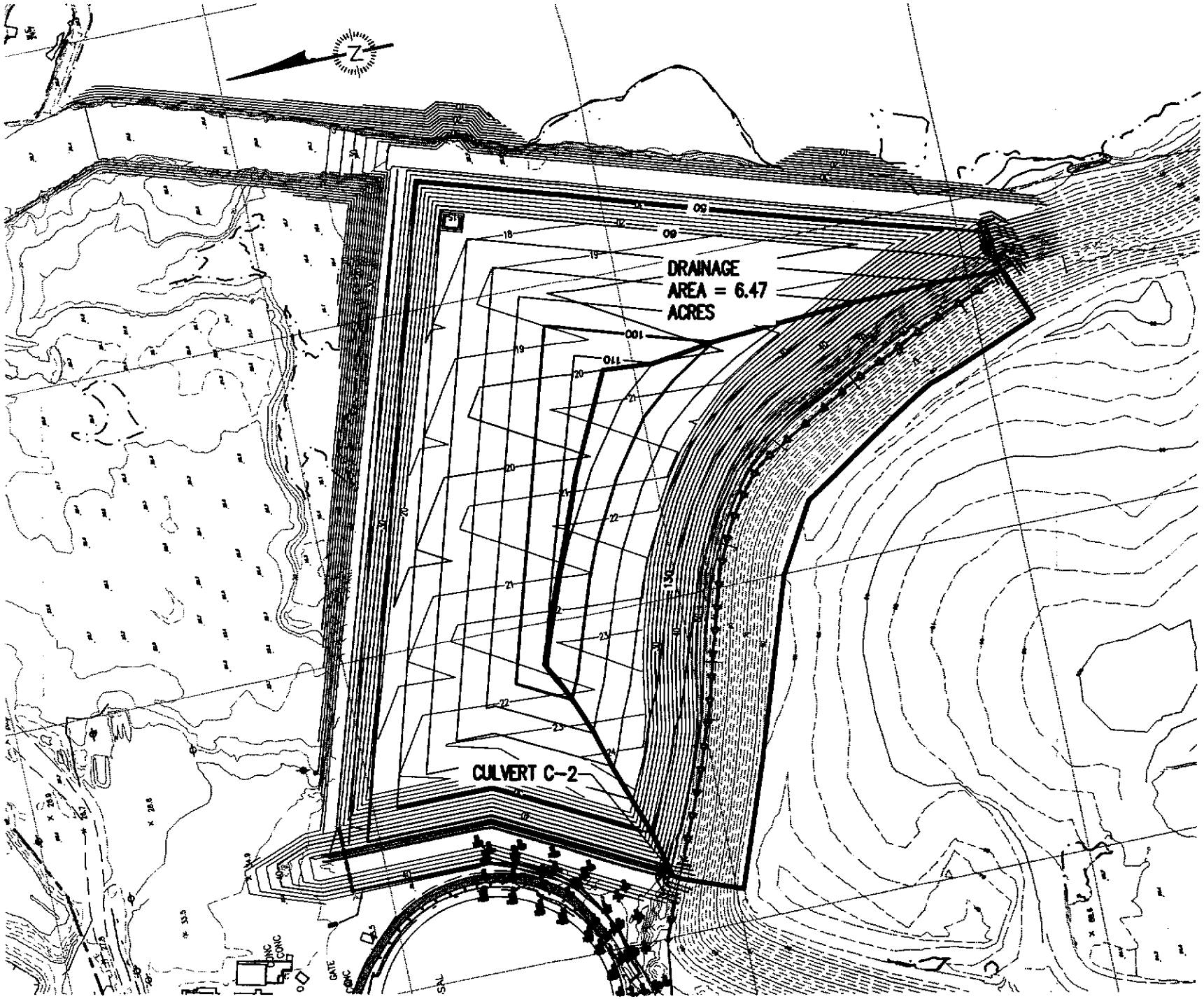
IP Riegelwood
Culvert C-2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963


DRAINAGE
AREA = 6.47
ACRES
CULVERT C-2

G.N. Richardson & Associates
Engineering and Geological Services
14 N. Boylan Avenue Tel: 919-828-0577
Raleigh, NC 27603 Fax: 919-828-3899

SHEET: /
JOB #: IP-6
DATE: 6/5/07
BY: KBS / GGM
CHKD BY:

International Paper Riegelwood
Drainage Channel DC-5 Analysis (Rip Rap Lined)

Channel No. DC-5 West side of landfill, to ASB Ditch

Design Parameters:

PEAK DISCHARGE, Q100 = 39.0 ft³/s Source: Rational Method

Bottom Width, B = 5.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical

Minimum Freeboard = 0.5 ft

Maximum Channel Slope, S_{max} = 0.002 ft/ft
Minimum Channel Slope, S_{min} = 0.002 ft/ft

Rip Rap Lining:
D_{50} = 0.33 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 1.3 lb/ft²

Max. Area = 19 ac
Fall = 27 ft
Hydraulic Length = 2624 ft
Time of Concentration = 20 minutes
Rainfall Intensity 6.85 in/hr 100 yr storm
Rational C = 0.3
Peak Discharge 39.045 CFS

Normal Depth

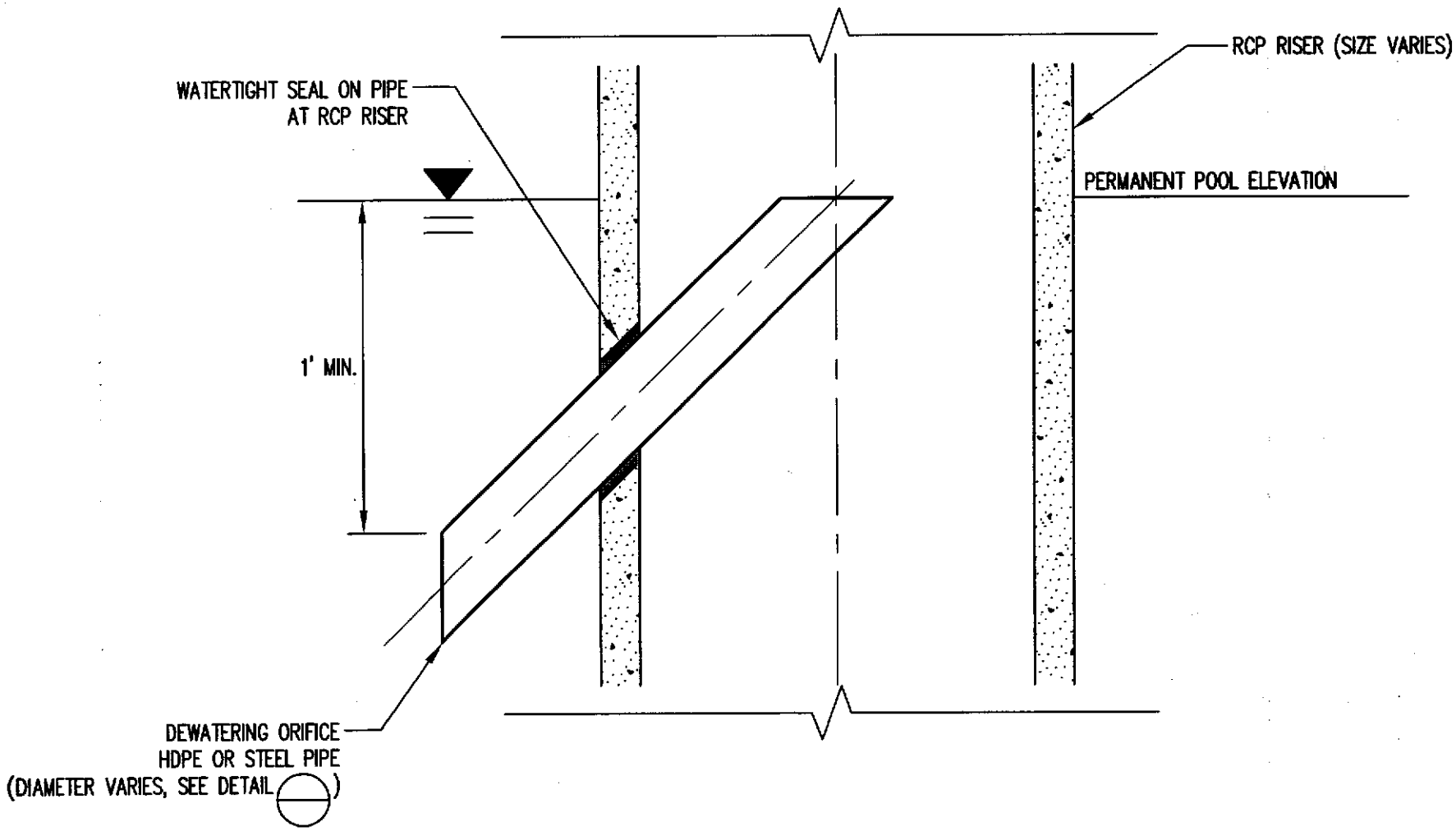
Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft²	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft³/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft²	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:													
1.99	0.036	17.94	13.92	1.29	12.98	1.38	2.17	38.9	0.33	0.2	V	6.0	O.K.
Minimum Slope:													
1.99	0.036	17.94	13.92	1.29	12.98	1.38	2.17	38.9	0.33	0.2	V	6.0	O.K.

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft²	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ ft$^{2.5}$	Flow Rate Q ft³/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
1.07	0.040	7.59	9.76	0.78	9.26	0.82	6.88	39.0	5.14	1.00	0.027	Flow is Stable.

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
2.49	14.98	2.49	14.98


WATERTIGHT SEAL ON PIPE
AT RCP RISER
RCP RISER (SIZE VARIES)
PERMANENT POOL ELEVATION
1' MIN.
DEWATERING ORIFICE
HDPE OR STEEL PIPE
(DIAMETER VARIES, SEE DETAIL)